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ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Face Detection and Recognition with Python

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ABSTRACT

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Name of thesis ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING. Face Detection and Recognition with Python.		
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<p>The main aim of this thesis was to detect the face in an image and its recognition using Python programming language along with OpenCV computer vision library. The practical framework of this research was mainly focused on face detection and recognition. The Haar Cascade algorithm was used for face detection purposes. For facial recognition, the Local Binary Pattern Histogram Algorithm was used. The rapid growth of artificial intelligence and machine learning technology in today's generation has taken the world to the next level. Furthermore, many impossible circumstances that are challenged by human beings can be solved with the aid of the latest technologies such as artificial intelligence and machine learning.</p> <p>Artificial intelligence and machine learning have wide applications in different fields. For example, computer vision, robotics, medical treatment, gaming, and industries. Data is essential for machine learning and artificial intelligence as well as in many projects. To understand artificial intelligence simply, it helps to unlock any devices like smartphones that recognize the face. Furthermore, the thesis explains the development trend of artificial intelligence as well as machine learning and the area of applications. Therefore, the thesis is a complete package of theoretical knowledge along with the practical implementation of artificial intelligence and machine learning application.</p>		
Key words Algorithm, Artificial intelligence, Data, Haar cascade, Machine learning, OpenCV, Python		

CONCEPT DEFINITIONS

List of Abbreviations

AI	Artificial Intelligence
CERN	The European Organization for Nuclear Research
CV	Computer Vision
DL	Deep Learning
GB	Gigabyte
GPS	Global Positioning System
IBM	International Business Machine
ID	Identification
IDE	Integrated Development Environment
LISP	List Processing
ML	Machine Learning
NASA	National Aeronautics and Space Administration
NumPy	Numerical Python
OpenCV	Open Source Computer Vision
PIP	Preferred Installer Program
RGB	Red Green Blue
SDK	Software Development Kit
QR	Quick Response
VR	Virtual Reality
XML	Extensible Markup Language

ABSTRACT
CONCEPT DEFINITIONS
CONTENTS

1 INTRODUCTION.....	1
2 ARTIFICIAL INTELLIGENCE.....	3
2.1 AI Development History in 20th Century	4
2.2 AI Development History in the 21st Century	7
3 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN GENERAL	10
3.1 AI and its Use-Cases.....	12
3.2 ML and its Use-Cases.....	14
3.3 Difference of AI and ML	17
4 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN PYTHON	18
4.1 Approaches	19
4.2 Libraries.....	19
4.2.1 TensorFlow	20
4.2.2 NumPy.....	20
4.2.3 Keras.....	20
4.2.4 Scikit-learn.....	21
4.2.5 Pandas	21
5 FACE DETECTION AND RECOGNITION WITH PYTHON	22
5.1 Requirements.....	24
5.2 Project Framework	25
5.2.1 Face Detection and Data Gathering	25
5.2.2 Training.....	28
5.2.3 Recognition	29
6 CONCLUSION	32

REFERENCES

FIGURES

FIGURE 1 Turing test model.....	4
FIGURE 2 The Sophia robot	8
FIGURE 3 Artificial intelligence, machine learning and deep learning.....	11
FIGURE 4 Types of machine learning	15
FIGURE 5 Python and OpenCV framework	22
FIGURE 6 Haar Cascade Features	23
FIGURE 7 Face features extraction	24
FIGURE 8 Steps involved in face recognition	25
FIGURE 9 Video capturing	26
FIGURE 10 Detected face with (x, y, w, h) coordinates	27

FIGURE 11 Face and eye detection28

FIGURE 12 Image data set29

FIGURE 13 Classifier training30

FIGURE 14 Recognized image.....31

1 INTRODUCTION

In this age of intelligence, people are surrounded by modern advanced technologies. With a small device as small as a palm, AI applications have given the possibility to access all the information around the world. Artificial intelligent software makes human life simpler in many ways. Also, the self-learning algorithms and the availability of online data with low-cost computation have taken machine learning to the next level.

The popularity of artificial intelligence has grown swiftly and has become part of everyday human life. The rapid development of modern intelligent technology has given hope for a better future for humanity. While the trend towards making intelligent machines had begun long before, the past few decades have been a dream about artificial intelligence for researchers and everyone around the world. The successes of AI have been demonstrated by increasing computing power and the ability to gather and store large amounts of data. The ability to understand and implement various kinds of knowledge in the real world is intelligence. Similarly, rather than being directed only by linear programming, a system that allows a computer system to learn from inputs is machine intelligence. Artificial intelligence is an interdisciplinary science also known as machine intelligence that mimics human intellectual behaviours and capabilities. In the present world, artificial intelligence is making life easier and simpler in many ways.

AI machines can react to inputs and they try to think like humans. Artificial intelligence is a vast topic on which there are many definitions. Artificial intelligence is a combination of the two words “Artificial” and “Intelligent”. Artificial relates to something that is not natural but made by human beings. In other words, a negative form of real things whereas Intelligence is the ability to think or understand. Intelligence consists of numerous pieces of knowledge and uses this knowledge to solve problems. Artificial intelligence is a new technology and the proposed definitions of artificial intelligence are different from each other. Moreover, there are a lot of works to be done. While looking at a broad scale, AI technology benefits society widely, better than humanity has ever seen.

Face detection and recognition is a well-known technology connected with computer vision and image processing that focuses on detecting human faces in digital images and videos. Face detection can be done either by using a specific face or multiple faces in an image. Face detection is a basic concept for tracking and recognition of faces. The main goal of this project is to detect a face in an image and

recognize the image by using artificial intelligence and machine learning along with various technologies. Python programming language and OpenCV computer vision library are used in this project. Overall, the project starts with the detection of a single face and the recognition will be done using the same facial image dataset where the program recognizes the person having a facial image.

2 ARTIFICIAL INTELLIGENCE

The definition of intelligence is the ability to understand and learn things. While artificial intelligence is a branch of computer science that emphasizes the creation of computers or machines as intelligent as a human being. Similarly, based on human intelligence, computer systems have been developed to enable them to perform their tasks. In addition, AI is defined as a variety of human intelligent behaviours such as memory, emotion, judgment, reasoning, proof, understanding, recognition, perception, design, communication, learning, forgetting, and thinking. Which can be artificially realized by the system, network, or machine. Artificial intelligence is computer-controlled machines or robots with human intellectual characteristics that learn from the experience and do various activities such as solving problems, thinking, playing games, understanding language, and diagnosing medical conditions. (Deyi Li 2017.) The father of artificial intelligence, John McCarthy says artificial intelligence is the science and engineering of making intelligent machines, especially intelligent computer programs. (Stuart & Russell 2003.)

AI is the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, and translation language between (Rouhiainen 2019). Moreover, artificial intelligence is a computer program or software with a mechanism to learn and decide to use past learning knowledge in a new situation. Some AI-powered machines can analyse massive volumes of information immediately without making errors, or the ratio of errors can be significantly lower as compared to the human. (Rouhiainen 2019.)

While AI-based technologies have been used in many areas, human pressure is getting lower. These tasks, which are difficult for human beings, boring and sometimes dangerous, can be done with the help of AI. One of the important features of AI is that it allows a machine to learn new things. The machine can act and react like humans if they have enough real-world related information. Artificial intelligence machines can learn themselves by using large amounts of data and recognizing patterns in the data. (Rouhiainen 2019.)

Artificial intelligence has been used in many major subjects including computer vision, machine learning, natural language processing, game theory, the science of cognition and reasoning, and robotics. Since the decade of the digital revolution, the rise of personal computers, and the birth of the internet. Most of these subjects were based on statistical methods, including learning and modelling. Equally,

advances in both hardware and software technologies have taken the AI field to the next level. (Kulkarni & Joshi 2015.)

2.1 AI Development History in 20th Century

Artificial Intelligence is one of the most mysterious subjects in computer science and has been studied for decades. Many scientists in the field of Engineering, Mathematics, and Computer science have tried to define the intelligence of the machine and have explored the possibilities of an artificial brain. Although, the journey of Artificial intelligence has started before 1950, but the term artificial intelligence was first coined in 1956 by John McCarthy when he held the first conference on the subject. (Smith 2006.)

British computer scientist Alan Turing worked to crack the ‘Enigma’ code which was used by German force to send a message securely during the second World War. Alan Turing with his team has created the Bombe machine which was used to decode Enigma’s message. (Ray 2018.) Turing proposed a solution to those questions with the help of the ‘Imitation Game’. According to Turing, a machine is said to be “intelligent” if that can converse with humans without the human knowing that it is a machine that win the “imitation game”. As a matter of fact, the imitation game also known as the Turing test which is an operational test of artificial intelligence for determining whether a computer is capable of thinking like a human being. Turing proposed that if a computer can be said to possess artificially intelligence if it can mimic human responses under specific circumstances. (Li 2017.)

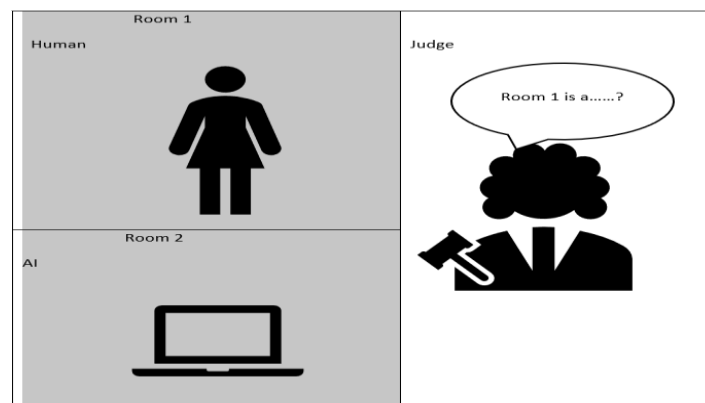


FIGURE 1. Turing test model (Rouse 2010).

FIGURE 1 explains the Turing test where a human interrogator, separate from the machine and another human, asks questions to a human and the machine at the same time. After getting the answer, the interrogator judges which answer came from the machine and which from the human. Turing proposed the test to determine the machine intelligence level.

Although artificial intelligence was coined officially in 1956, but the journey to think if a machine can really think began much before that. In 1942, the American writer Isaac Asimov published a story about a robot developed by two engineers, Gregory Powell, and Mike Donovan. Asimov introduced the three laws of robotics. Which explains that a robot may not harm a human being, a robot must obey the orders given by human and it must protect its existence. Later in the field of robotics, AI, and computer science, many scientists were inspired by Asimov's work. (Henlein 2019.)

Alan Turing, who is also known as the father of theoretical computer science and artificial intelligence, developed the bombe machine for the British government during the second world war. The purpose of the bombe machine was to break the Enigma code used by the German force to send a message securely. Later in 1950, Turing published an article, "Computing Machinery and Intelligence", in which he explained how to make intelligent machines and test their intelligence. (Haenlein 2019.)

Artificial intelligence was officially coined for the first time during the Dartmouth Conference in 1956. Two computer scientists, Marvin Minsky, and John McCarthy hosted the approximately two-month-long summer research project on artificial intelligence in 1956 at Dartmouth College, New Hampshire (USA). During the Dartmouth conference, the father of artificial intelligence John McCarthy officially coined the name of the field. The first artificial intelligence system was introduced by Newell, Shaw, and Simon in the year 1956. The introduced program was the logical theory program for solving mathematical problems. (Mijwil, 2015.)

John McCarthy developed a high-level programming language in 1957. LISP was a functional programming language developed for artificial intelligence. The dominant programming language helped to create flexible programs, including basic operations with a list structure. The first programmable industrial robot 'Unimate' was created in 1961. Unimate was aimed to work in a factory to move pieces of hot metal. Unimate is a pre-programmed autonomous robot invented by George Devol. One of the first programs to attempt the Turing test, the Eliza was created from 1964 to 1966. Eliza was a natural language processing computer program able to simulate the conversation with a human. It has designed at the MIT artificial intelligence laboratory. In Addition, it is also known as the first chatterbot Even

Though, the term chatterbot was not coined at that time. The year between 1966 and 1970 was known as the dark period for artificial intelligence. (Haenlein 2019.)

From the 1970s onward, development in artificial intelligence took another step. Many leading companies have started their research in areas such as machine learning, expert system, pattern recognition, and robotics. The WABOT-1 was the first full-scale humanoid robot built in 1972, which was able to walk and communicate with people in Japanese. In 1974, the first autonomous vehicle was created in the Stanford AI lab. By the same year, the Internet came in use for the first time. (Mijwil 2015.)

Since the 1980s, AI has expanded into a more extensive study of the interaction between the body, brain, and environment, and how intelligence rises from such interaction. In computer science and psychology, many algorithms have been applied to many learning problems. In 1982, Japan began a project to develop fifth-generation technology. The Ministry of International Trade and Industry of Japan had started the project to create computers using massively parallel computing and logical programming. The project aimed to build an intelligent machine with listening and speaking abilities. (Bala 2019.) Similarly, much of the work was done using neural networks. After much research and development in neural networks, ALAVIN was introduced as the first driverless self-driving vehicle using neural networks in 1986. Self-driving vehicles may seem like a recent technological phenomenon, but the engineers and researchers have been building self-driving vehicles for decades. ALAVIN was considered as the forefather of today's self-driving cars. (Hawkins 2016.)

In 1997 an IBM computer called IBM Deep Blue; a chess-playing computer developed by scientists at IBM beat the world champion chess player Garry Kasparov. Computer scientists were able to compare the human mind with the computer's computational ability. Deep Blue was programmed to solve a complex, strategic chess game. The chess-playing computer could explore up to 200 million possible chess positions per second. After its success, it enabled researchers to understand and explore parallel processing. At the same time, developers were inspired to design a computer to tackle different problems in other fields, using deep knowledge to examine a higher number of possible solutions. (Greenemeier 2017.) Furthermore, Sony introduced the autonomous robot "AIBO" in 1999. It is a four-legged robot designed for home entertainment purposes. AIBO can act on its judgment and in response to external stimuli. Due to having various sensors and autonomous programs, AIBO can behave like a living creature. (Wee 2005.)

2.2 AI Development History in the 21st Century

Since the starting of the 21st century, the field of artificial intelligence has shown an upward trend in growth. The development of human society has advanced due to the evolution of AI. However, the field of AI is still difficult to understand because of the rapidly growing multidisciplinary features. Nevertheless, artificial intelligence technologies are growing rapidly. Improvement in machine learning, big data, cloud computing, and advanced AI algorithms have resulted in the acceleration of AI development and implementation. (Liu 2018.)

During the 21st century, the way of using AI has changed. In earlier times, AI was mainly used in factories or in terms of communication. AI is now used in Internet search engines, voice recognition software, automobiles, home appliances, consumer electronics, corporations, groups of agents, and networks. However, there is still research going on to be able to completely understand the natural forms of intelligence. The focus areas of AI in the 21st century are games, expert systems, neural computing, evolutionary computation, natural language processing, and bioinformatics. (Lucci 2015.)

Since the starting of 2010, AI technology is being going mainstream. AI has beaten professional gamers in many games. DeepMind and IBM Watson have shown that in some ways a machine can outsmart humans. Deep learning using neural networks became popular in identifying the images using raw data. Without human programming the AI system became self-learning. (DeBos 2019.) Similarly, company iRobot introduced a robot called Roomba. Roomba is a floor cleaning robot that cleans the floor without human intervention. It is a battery-powered vacuum cleaner with basic AI capabilities, such as identifying walls and avoiding stairs with the use of built-in sensors. (Farfinkel 2002.)

Google began manufacturing a self-driving car in 2009. The vehicle could drive itself using artificial intelligence software. With AI software, the car drove hundreds of miles, at first without human intervention. The software could sense anything near the car and mimic the decision made by the human driver. The self-driving car followed all the traffic rules and speed limits, and all the data provided in the software made it easier to follow the GPS navigation system. (Markoff 2010.)

Apple introduced the first modern digital virtual assistant (Siri) in the year 2011. For decades, communicating with the concept of AI via spoken word was a dream. But in the year 2010, Apple integrated a

machine-learning assistant into its iPhones. Simply, Siri works with two main machine learning technologies: NLP (Natural Language Processing) and Voice Recognition. With the help of the NLP algorithm, Siri can understand, analyse, manipulate, and generate human language. It then converts the human voice into its corresponding textual form. Since the starting of Siri, the Apple product teams have been continuously engaged in the development of AI features such as machine hearing, speech recognition, machine translation, natural language processing, text to speech, and improving the lives of millions of customers every day. (Apple at NeuralIPS 2019.)

Similarly, Google has launched a digital virtual assistant that works the same as Siri. It interprets human speech and responds via synthesized voices. Moreover, Amazon Alexa is a smart virtual assistant AI developed by Amazon. To match user text or voice input to an executable command, a virtual assistant uses natural language processing (NLP). Having a large amount of information on a device or online, intelligent personal assistants can perform a variety of tasks. (Voice Assistants 2020.)

Self-learning AI became successful and better at playing games. In 2015, DeepMind's AlphaGo program became the first computer Go program to beat a professional Go player. Go is a board game where players move two different coloured stones, either white or black, in which each player must either capture empty spaces or surround the other. (Lee 2019.) Google's DeepMind AI successfully beat the legendary player Lee Sedol. Using deep learning and neural networks, AlphaGo teaches itself to play. The working principle of AlphaGo is that DeepMind reinforces and improves the system's ability continuously by allowing it to play millions of games against a modified version of itself. It is an example of deep learning using neural networks but taught by a mixture of reinforcement learning and supervised learning. (Hern 2016.)

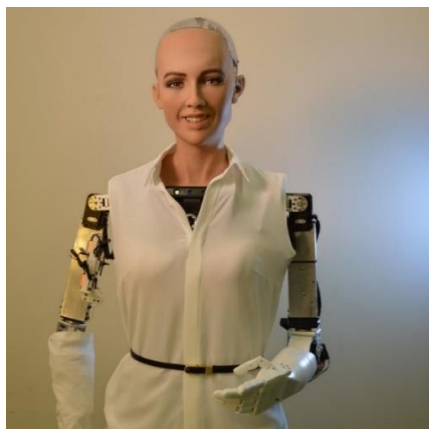


FIGURE 2. The Sophia Robot (Kom 2018).

Sophia robot in FIGURE 2 was created by a Hong Kong based company, Hanson Robotics in 2016. Sophia is a unique combination of science, engineering, artistry, and a platform for AI research and advanced robotics. The world's first robot citizen Sophia was created using symbolic AI, an expert system, neural networks, machine perception, conversational neural language processing, and adaptive motors. With machine vision, Sophia is able to recognize human faces, see the emotional expression, and recognize different hand gestures. Occasionally, Sophia can operate herself in fully AI autonomous mode, but she has mentioned that “no AI is nearly as smart as a human, not even mine”. (Robotics 2020.)

An important breakthrough in AI development occurred in the year 2018. The non-profit AI research company Open AI created AI technology that was able to defeat the top human team in the multiplayer strategic game Dota 2. The AI-based players were able to train themselves by playing the game multiple times, and they were able to gain knowledge in one day, which would take a human 180 years to learn. This achievement said a lot about the possibility of AI solving real-life problems in the future. (Rouhainen 2019.)

Nowadays, AI is used in numerous different fields. It is used for planning and scheduling projects for spacecraft. It is also used in chess, AlphaGo, autonomous processes in automobiles, or medical diagnoses like lymph node pathologies. These are just a few examples of the many fields in which AI is used. (Russel & Norvig 2003.) In the future, the impact of AI will become even better because of cheap and increasing storage capacities. AI will be extremely useful in businesses, healthcare system, public sector, and social interaction. In particular, the need for machine learning will still increase because it will be necessary to predict analytics like prices and product optimizations. (Kamath & Chopella 2017.)

3 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN GENERAL

The term artificial intelligence and machine learning has been a buzzword for the past few years. Many people believe that the term AI and ML are similar. They lie in the same category, but to make it simple, machine learning is just a branch of artificial intelligence and AI is a whole tree. Artificial intelligence is the development of intelligent computer systems capable of performing tasks that traditionally require human intelligence. It is a very vast field of study, inside of which machine learning is an application of AI that trains a machine about how to learn from the experience or learn itself using lots of available data. In machine learning, computer systems perform a specific task with the help of different algorithms and statistical modules. Machine learning is a vital way for computers to achieve artificial intelligence. (Rouse 2010.)

The application of artificial intelligence and machine learning has become popular in recent years. Both terms have been used regularly in different sectors. Machine learning explains a set of concepts that are frequently solving different real-world problems with the help of computer systems. The idea behind machine learning is that the systems could learn from data, identify patterns, and make the right decision with minimal human intervention or without human intervention. When the machine starts working with complicated algorithms instead of basic algorithm, it can be considered autonomous or self-conscious. There are many uses and functions that are possible with computer systems such as Game development, data analysis, research, web page creation, mathematical calculation, and many more. Similarly, machine learning aims to acquire new knowledge or skills and arrange a knowledge structure that allows for continuous improvement in its achievement. Machine learning is an essential way to enable computer to have intelligence. (Rouse 2010.)

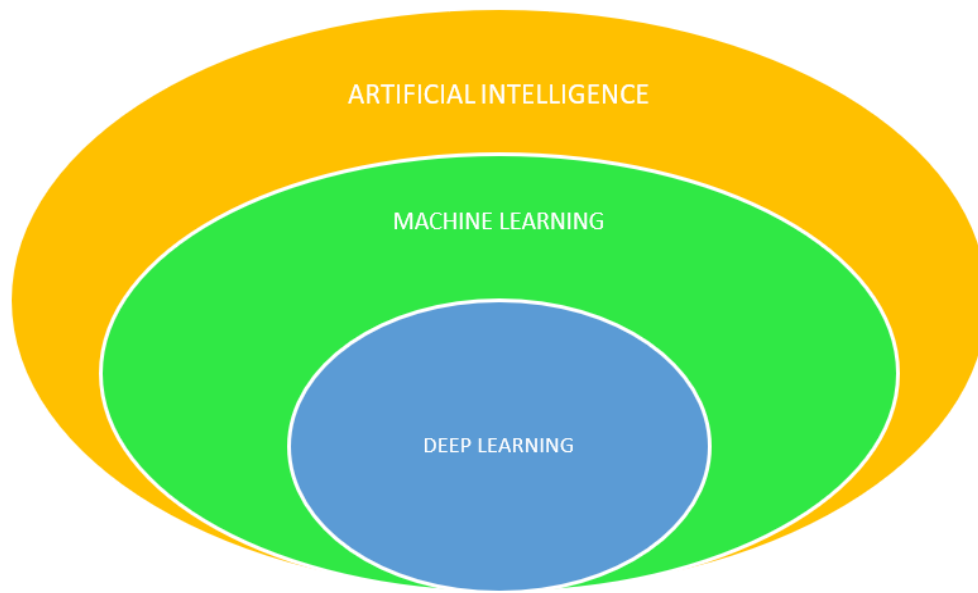


FIGURE 3. Artificial Intelligence, Machine Learning, and Deep Learning (Rouhiainen 2019).

The above FIGURE 3 explains the relationship between artificial intelligence, machine learning, and deep learning in which, AI tries to create human-level intelligence, ML is a hybrid strategy in which software learns patterns in raw data that were not programmed by a human, and DL is the faster way of building advance intelligent agent. Machine learning and deep learning uses an algorithm to train a module and helps to achieve artificial intelligence. (Rouhiainen 2019.)

Data is an essential for machine learning, AI, or in the current technological wave. For example, there can be thousands of great engineers who will not be able to make a system that understands human conversations. They will not be able to build a system that will recognize scenes of images or objects. They need to have data to build a system that understands the surroundings and learns itself. Developing an AI application and products without data is nearly impossible. Additionally, the world's largest and most valuable companies are the ones that have access to the largest quantities of data. Similarly, the development of AI tools has given the potential to analyse different kinds of structured and unstructured data. One example of this is the amount of data Google search engine encompasses, as well as the powerful social network Facebook would not be popular among people without having access to data on people's social trends. (Rouhiainen 2019.)

Deep learning is synonymous with machine learning. In other words, it is a subset of machine learning which is a subset of AI. Deep learning is one of the most powerful and fastest-growing applications of

AI. Strong computation and more data sets are required to work for deep learning. In contrast, AI is the human intelligence exhibited by machines, an approach to achieving artificial intelligence is machine learning, and a technique for implementing machine learning is called deep learning. The technical term deep learning refers to deep artificial neural networks which are a set of algorithms and have set a record in accuracy for many problems for example, sound recognition, image recognition, natural language processing, and recommender system. One example of deep learning is the most popular AlphaGo algorithm created by DeepMind. The algorithm won against former world champion Lee Sedol at the traditional Chinese game Go in the year 2016. (Nicholson 2019.)

3.1 AI and its Use-Cases

Artificial intelligence is not a new topic, but many people still believe that the term AI is just something the big companies are focused on, and it has no impact on their everyday life. In fact, people experience AI in their everyday life from morning to night. The use of smartphones is common nowadays. The Face ID unlocking system which allows users to unlock the device is popular among the users. The system analyses multiple parts of a face, including eye placement, nose width, and the system combines these features into a unique code and identifies the specific face. An automatic voice assistance system is another example of an everyday used AI system that many users have been using frequently for various tasks. (Rouhiainen 2019.)

AI is used in various fields such as industry, business, communication, the job market, games, robotics, and traffic. In terms of industries, AI is already a significant part of it in the society. The industry sector can be divided into finances, travel, health care system, retail, transportation system, journalism, education, agriculture, entertainment, and the government. When it comes to finances, AI will become increasingly important to collect data about consumers and interact with consumers based on gathered datasets. Customer service online or on the phone will become faster, less expensive, and more efficient with the help of bots. Security in the financial sector will improve as well, as AI-provided systems can identify and block illegal access points. The bots will also offer advice and advertising based on customer preferences. Still, interaction with humans will be needed and cannot be completely replaced by bots. (Rouhiainen 2019.)

Considering the travel industry, the process of booking hotel rooms may become easier by using voice commands or chatbots. The service in the hotel rooms itself may be performed by services like Amazon and Apple. The check-in system in hotels or airports may soon be implemented by facial recognition, making this process easier, faster, and safer. However, the way of handling privacy is currently still under discussion. By using facial recognition, there would be much more data and it needs to be solved where this data should be stored and who could have accessed to it. The way of protecting personal data needs to be clarified first before using AI. Due to advancements in biometric technology, various businesses have been using facial recognition systems to help people save their time. An example of a facial recognition system is that Finnish airline company Finnair has started testing facial recognition tools at Helsinki airport, which will help travellers to save their waiting time and check-in without having a physical boarding pass. In addition to this, AI is used to improve hotels or airlines by analysing comments and recommendations written by costumers online. Furthermore, traveling in cities should be improved by creating “smart cities”. Sensors should measure pollution in certain areas of cities so that the transport system can be improved, and that the government can build a more environmentally friendly city. (Rouhiainen 2019.)

AI is also a very important aspect of the health care system. For many years AI has been utilized to analyse medical data and provide information about the diagnoses, treatments, and patient care in general. AI is used for the diagnosis of cancer or eye-diseases and for giving recommendations for the treatment. Similarly, patient can perform diagnostic tests, measure their medication, or register their health status at home just by using their smartphone. Also, robot-assisted surgery or nursing is going to be implemented soon. However, there are still ethical concerns if human life is at risk due to the errors cause by AI. (Rouhiainen 2019.)

Considering the retail industry, AI is going to be a big part of online shopping as well as physical retail. Many markets already offer automatic payment machines, which make the process of buying the products even faster. Another example is at Amazon store where products taken from the shelf are added to the buyer's Amazon account directly by sensors and are paid when the customer leaves the shop. In different retail stores, robots are used to refill the shelves and provide inventory. (Rouhiainen 2019.)

The use of AI in the gaming industry is extensive and it continues to expand rapidly. The game industry uses AI to design intelligent agents that can compete with humans. The computer follows the same strategy as humans while playing the game, but the difference is that it follows the search algorithm for strategy and the human uses brain. The objective of the search algorithm is to search for the optimal set

of moves, which is different for different games. Similarly, AI-powered games are designed with the purpose of studying their pattern to improve their algorithm, which is a way for AI to advance and further development. (Togelius 2018.)

Artificial intelligence is everywhere in our society and benefiting different industries such as the smart education system, agriculture, journalism, entertainment industry, government, and many more. AI technology has been on the market for a few years and is already changing everyday lives, economy, and the society. (Togelius 2018.)

3.2 ML and its Use-Cases

Machine learning is the way to design an algorithm that allows a computer to learn. Learning is one of the most important features of intelligence. Learning can be explained in different ways, including various results such as dealing with new scenarios and surroundings and the ability to adjust to a changing environment. When it comes to AI, machine learning is the field of computer science, more precisely an application of artificial intelligence, which gives computer systems the ability to learn data and progress from experience without being clearly programmed. The AI learns to create a positive and useful approximation to get an overview of a large amount of data, which is constantly increasing since everyone has access to computers and wireless connections. These processes are needed to identify, understand trends, and make future predictions based on the previous data. (Alpaydin 2014.)

One example of predictions can be found in online selling. AI is associating which consumers are buying which products and creating coherences to modify the publicity on the website for consumers with similar buying habits. The application used for this process is called data mining. Data mining is needed in many fields, such as finance, medicine, telecommunication, and many more. All these fields are constantly changing. Therefore, AI also needs to learn and analyse changes and react correctly. (Alpaydin 2014.)

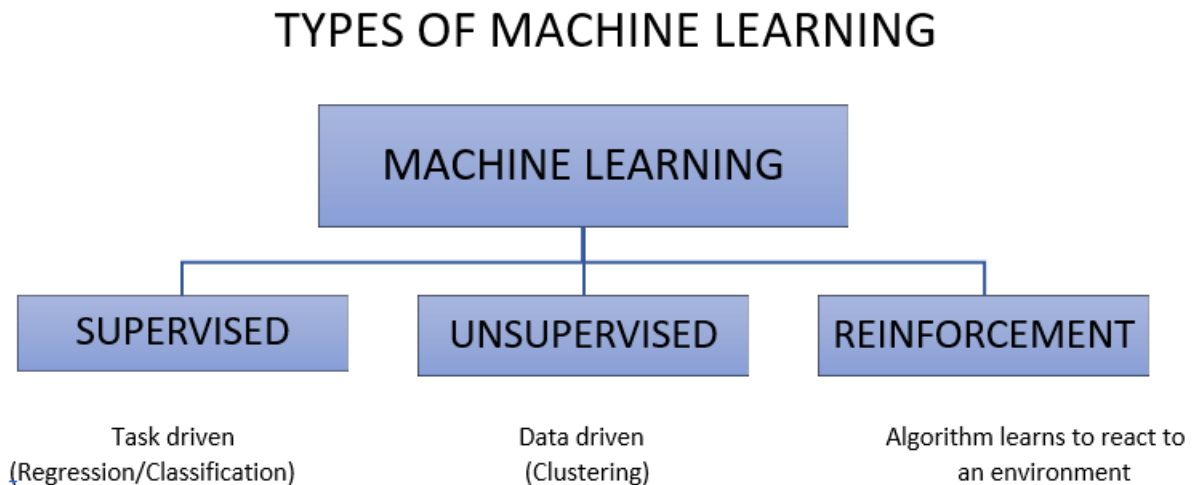


FIGURE 4. Types of Machine Learning (Rouhiainen 2019).

FIGURE 4 shows the different machine learning algorithms where supervised machine learning deals with regression and classification algorithms. In which data is given to the machine along with the desired output, the algorithm provides the expected output result. Unsupervised machine learning deals with clustering algorithms. Similarly, in unsupervised machine learning, the algorithm tries to extract features and patterns automatically from an unlabelled dataset. Reinforcement machine learning algorithm learns to react to the environment. In reinforcement machine learning, the user makes the decision.

Supervised machine learning is the most common type of machine learning and it is based on labelled data. Some verification data are provided to the machine for learning whereas machine studies by itself and develop the ability to recognize new data based on the given data. The training data has the answer key with it so the model itself trains with the correct answer. Without any help from a human, the algorithm can generate output for an input it has never seen before. (Muller 2016.) The machine must differentiate between categorical and numeric data types. If the dataset is categorical, the machine must create classifications and arrange the data into the right categories. If the dataset is numeric, the machine must calculate predicted numbers and give an idea about upcoming trends. One example of categorical datasets is the detection of fraud where the information can be categorized into true or false. An example of numeric data is the prediction of a price for selling a house. Decision tree, Logistic, Random forest, Regression, are examples of supervised machine learning algorithms. (Kamath & Chopella 2017.)

In the case of unsupervised learning, the dataset is unstructured and not explicitly labelled. The computer itself finds the patterns and relationship between various data sets. This kind of machine learning algorithm does not have any human support to give guidance. Therefore, unsupervised machine learning algorithms are called true artificial intelligence (Soni, 2018). The machine needs to cluster the given data, manifold learning, and then detect outliers to completely structure the data and be able to make predictions for the future. An example of unsupervised learning is the clustering of the purchasing habits of costumer. (Kamath & Chopella 2017.)

The process of the reinforcement learning algorithm describes the way an application creates a policy for certain data. The algorithms in reinforcement learning train the systems to make a particular decision by exposing the system to the environment where it trains itself using the trial and error method continuously. Without having the training dataset, it is bound to learn from its experience. The aim is to create consistent policy and to identify the data which fits into it. An action does not need to be good by itself, it needs to be a good part of the whole structure. A given example in the domain of AI games is chess games. In this case, it does not count if a move is good by itself but if it is helpful for the whole process of the game. (Alpadyin 2014.)

Many different companies are using machine learning to improve business performance, make strategic decisions, and save money. One of the most frequently used machine learning applications is objected recognition. Many companies from different industries use object recognition. Detecting diseases using object recognition algorithm in healthcare, robot and self-driving cars in the automotive industry, face recognition in cybersecurity, social media, content personalization, and individualized recommendations, fraud detection, and natural language processing. are the real-life examples of machine learning. (Clariba 2020.)

Personal virtual assistants such as Siri, Alexa, Google Now in smartphones, and smart home devices use machine learning to understand the voice of users and change it to static text without realizing the complexity behind the system. Millions of consumers use this technology almost every day. The dynamic pricing strategy in the travel industry uses machine learning for price change in many flights and hotels. Similarly, email spam and malware filtering are also a classic use of machine learning. A trained model identifies whether the email is spam or not and separate automatically in the spam folder if the email is spam. Moreover, online retailers use machine learning to recommend the product to the consumer. Based on the previously purchased items or products, the machine learning model recommends a similar product to the consumer. Movie recommendation from Netflix, Google search engine, and YouTube, are also

popular machine learning recommendation systems. Detection of fraud in the banking sector using machine learning is essential for the security of customers and employees. (Sharma 2019.)

3.3 Difference of AI and ML

Machine learning is the concept under AI where enough data and computational power allows the machine to learn on its own. Both the terms are part of computer science that are correlated with each other. AI and ML are the most popular technologies in the field of computer science. Although both the technologies are related, in various cases these techniques are different. (Nicholson 2019.)

On a broad scale, AI is a concept to develop intelligent machines that can mimic human thinking behaviour and capability whereas machine learning is a subset of an application of AI that allows machines to learn from data without being explicitly programmed. AI system uses different algorithms which can work with their intelligence and AI system does not need to be pre-programmed because it uses many machine learning algorithms such as deep learning, neural networks, reinforcement learning algorithm and many more. Artificial intelligence technology allows a machine to mimic human behaviour which leads to the creation of a smart computer system to solve complex problems. Artificial intelligence can use to perform various tasks based on its capabilities. Some of the real-time applications of AI are Siri, Expert system, online game playing, customer support system using the chatbot, and intelligent humanoid robot. (Oppermann 2019.)

Similarly, having a subfield of artificial intelligence, machine learning allows the system the ability to learn and improve automatically from previous data or experience. It uses various structured and semi-structured data to create accurate data or give predictions based on that data using the machine learning model. The machine learns from given data as well as maximizes the performance of it and aims to increase accuracy more than success whereas AI works as a computer program that does smart work and aims to increase the chance of success more than accuracy. Thus, machine learning can be developed without AI. Nevertheless, artificial intelligence cannot exist without machine learning. As described, both the terms are related to each other, and machine learning is a part of artificial intelligence. (Kulkarni 2015).

4 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN PYTHON

Python is an interpreted, object-oriented, high-level open-source programming language with strong semantics developed to be easy to read and simple to implement. Having a high-level built-in data structure as well as clear syntax makes it very fascinating for fast application developments. Python is simple, easy to learn, and supports modules and packages that endorse program modularity and code reuse. Python was created by Guido van Rossum in 1991 and developed by the Python Software Foundation. It is a highly popular programming language because it allows programmers to write complex tasks. Additionally, Python is a programming language for developing an application in a variety of fields, including AI and machine learning, data science, web development, and the Internet of Things. Python is a popular programming language among professionals because of its simplicity and easily readable syntax. In addition, having an integrated language, Python provides various data processing. Many companies and organizations such as Google, Yahoo, CERN, and NASA are using Python programming language for software development. (Helterman 2011.)

Python programming language provides a framework which allows programmers to complete their tasks in just a few lines of code. Also, it can be used in various environments, from mobile and web development to desktop application and hardware programming. As compared to the other programming languages, Python is frequently used programming language in most of the technologies for instance, data science, computer vision applications, and machine learning. (Neli 2018.)

Artificial intelligence and machine learning are the trending technology of the future. There have already been many applications made on AI and ML. Because of this, many organizations and researchers are satisfied. Programming language plays a vital role in the development of AI and ML applications in which the language use for programming must be flexible, stable, and have available tools. There are many programming languages such as Lisp, C++, Java, Prolog, and Python, which are available for developing the application of AI and ML whereas Python programming language gains the most popularity among them. (Beklemysheva 2020.) Versatile workflows and complex algorithms stand behind machine learning and AI, where Python provides concise and readable code. Correspondingly, Python programming language comes with a large number of inbuilt libraries. Many of them are for artificial intelligence and machine learning. Hence, it allows programmers to write a reliable system. The feature of the Python programming language is that it requires less coding and simple syntax. Because of these features, testing can be easier, and the developer can focus on programming causing from technical

language problems. Similarly, machine learning requires continuous data processing where Python libraries help to access, process and transform data. (Solem 2012.)

4.1 Approaches

Having a subfield of AI, machine learning uses data and sophisticated math to make better decisions and predictions. Both terms are different from each other, not only in approaches but also in logical thinking and algorithms. The target could be correctly detected and identify the exact face of an animal or human, board games, and able to drive a car from sensors without human intervention. All the goals mentioned are accomplished with the help of different technologies and algorithms. Some of the real-world examples that work with the help of algorithms are self-driving cars, bank fraud detection, Netflix recommendations, and personal assistance. Consistency, accuracy, and performance are the three main parts in AI that major companies are working on. Besides, these technologies have been in use for a long time and are very effective. (Kaput 2020.)

Within a few years, artificial intelligence and machine learning will become common in many sectors of human lives. There will be improvement in education, health care, public safety, and transportation. There have already been wide range of applications for artificial intelligence and machine learning in many fields such as computer vision, robotics, augmented reality, virtual reality, QR code and bar-code scanning and fingerprint scanning. However, applications of computer vision have been used primarily in all areas of society. (West 2018.)

4.2 Libraries

Libraries are programs and sets of functions written in a specific language that help developers with various tasks. The existing artificial intelligence and machine learning algorithm require a well-tested and well-structured environment that allows the developer to execute the best quality coding solutions. There are many Python libraries for artificial intelligence and machine learning. The built-in modules in the library provide access to system functionality, such as file input/output. In addition, modules written in Python provide solutions to common programming problems. To reduce development time, Python offers a pre-written program that is ready to use on common coding tasks. (Beklemysheva 2020.) Some

of the best Python libraries for AI and Machine learning are TensorFlow, NumPy, Keras, Scikit-learn and Pandas.

4.2.1 TensorFlow

TensorFlow is an open-source Python machine learning library for numerical computing and accessible to all. It was developed by the Google Brain team and is used in almost every Google application for machine learning. It enables the developer to visualize the creation of a neural network with a tensor board. As compared to another popular Deep Learning framework, TensorFlow offers excellent service and functionality. It helps researchers and developers to understand the implementation of operations across the network by providing network control. Additionally, it provides readable and accessible syntax, which is important for making programming resources simple to use. The most widely used TensorFlow's machine learning application is neural networks that can recognize faces and analyse handwriting. (Shetty 2018.)

4.2.2 NumPy

NumPy is a Python math library. It is a library for the large multi-dimensional array as well as matrix processing, which also assists in effective and efficient computation with the help of a large collection of high-level mathematical functions. In machine learning and AI, it varies useful for scientific computation with Python. Similarly, comparing with other Python lists, it offers an extensive N-dimensional array interface and linear algebra function that are orders of magnitude faster and more memory efficient. Therefore, it is essential for machine learning and simulation. (Solem 2012.)

4.2.3 Keras

Keras is an open-source machine learning library written in Python. It is simple, easy to use and it gives clear and actionable feedback for most errors. Keras functions as a user-friendly, and extensible interface rather than being an end-to-end Python machine learning library. Keras is popular among deep learning

researchers and it has been used by researchers at major scientific organizations, such as NASA and CERN. (Claire 2020.)

4.2.4 Scikit-learn

Scikit-learn is an open-source Python library which provides a selection of supervised and unsupervised learning algorithm via a compatible interface. It performs various algorithms such as clustering, classification, and regression having support vector machines, decision tree, naive Bayes, random forest, k-means density-based spatial clustering of application with noise (DBSCAN). As well as it interacts with Python numerical libraries for example, NumPy and SciPy. (Isoni 2016.) In the same way, the Scikit-image library is an image processing library that includes algorithms for colour space manipulation, segmentation, geometric transformation, analysis, filtering, feature detection in image, and morphology. It is written mostly in Python language and can be interoperated with SciPy and NumPy. (Gouillart 2020.)

4.2.5 Pandas

Pandas are one of the most powerful libraries for manipulating, analysing, and cleaning data with Python. It works with labelled data and rational data which helps to import, analyse, and visualize data. It is a widely-used open source library intended to be a fundamental building block for real-world data analysis in python. Furthermore, it is a data analysis library that provides a wide variety of tools for manipulating high-level data structures. Pandas provide built-in methods for combining data, grouping, and filtering corresponding to the time-series functionality. (Santos 2019.)

5 FACE DETECTION AND RECOGNITION WITH PYTHON

Face detection and recognition is the most popular computer vision technology within the artificial intelligence landscape due to its varied range of applications. Face recognition is the process of identifying a person by mapping facial features by using various methods. Face plays a vital role in communication, information about people, identifying people, and understanding the emotion through facial expressions. Because of the uniqueness of the face and the different parameters, it helps us recognize the person. Therefore, face detection and recognition are essential for numerous applications including face tracking, video surveillance, face recognition, virtual reality, and a security system. (Zoccolan & Rust 2013.)

Recognizing faces is an easy task for a human. Whether it is internal or external features, the human brain has nerve cells specialized in recognizing specific local features of a scene, such as edges, lines, angles, or movement. For computers, it uses an algorithm to pick out distinctive details about a person's face such as skin colour, face position, shape, and distance between the eyes. (Zoccolan & Rust 2013.)

The goal of this project was to detect a face of a person and recognize it in real-time using a webcam. There have been many platforms for creating machine vision applications. But in this project, Python programming language has been used along with OpenCV, Open source computer vision and machine learning software library, which focuses strongly on real-time applications. Therefore, it is reliable for real-time face detection and recognition using webcam as well as in pictures. The project started with face detection using Haar Cascade pre-trained classifier for faces and eyes. Similarly, for recognition, the classifier has been trained using multiple facial images with specific identification. And the trained classifier has been used for real-time recognition. (Emami 2012.)



FIGURE 5. Python and OpenCV framework (Liao 2016).

FIGURE 5 denotes the logo of OpenCV and Python. Open-source computer vision (OpenCV) is a library for computer vision applications. It is an open-source library developed to provide real-time image processing and computer vision applications. Although written in C++ it is content with other programming languages such as Java, Python, Ruby and Android SDK. OpenCV is one of the most popular libraries for image and video processing due to its ease of use and readability. OpenCV is compatible with most of the operating systems. (Emami 2012.)

Computer vision programming is simplified by using OpenCV. Having built-in features and advanced capabilities such as face detection, face recognition, face tracking, Kalman filtering, and many artificial intelligence methods makes it better and ready to use. Similarly, OpenCV is the multi-platform framework that supports Windows, Linux, and Mac operating systems. Many developers can easily use OpenCV in their desired framework with only basic knowledge of how all methods work. OpenCV provides all the modules for face recognition and makes coding easier. (Rosebrock 2018.)

Face detection and face recognition are not the same, but face recognition needs face detection for making identification to recognize a face. Face detection uses algorithms to detect a face in an image. The Haarcascade algorithm has been used for this project, which is a machine learning object detection algorithm where the cascade function is trained using thousands of positive and negative images to achieve more accuracy. OpenCV provides pre-trained Haar Cascade algorithms, organized into different categories such as faces, eyes, smile, body, depending on the trained image. Thus, pre-trained Haar Cascade algorithms had been used for detection purposes. The working principle of the Haar Cascade algorithm can be seen in the FIGURE 6. The main concept of Haar Cascade is to extract features from images by using a filter. These filters are known as Haar features. (Dwivedi 2018.)

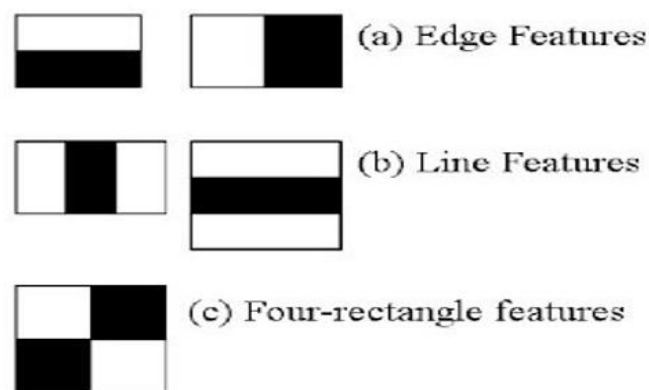


FIGURE 6. Haar Cascade features (Dwivedi 2018).

FIGURE 6 shows some Haar-features, where the first two features are “edge features”, used to detect edges. Similarly, the second two are “line features”, and the third feature is “four-rectangle features”. Haar Cascade uses a machine learning technique to train a function with positive and negative images. Positive images contained the images of faces, and negative images contained images without having faces. A theoretical face model having facial features (i.e. eyes, nose, mouth) is shown in FIGURE7.

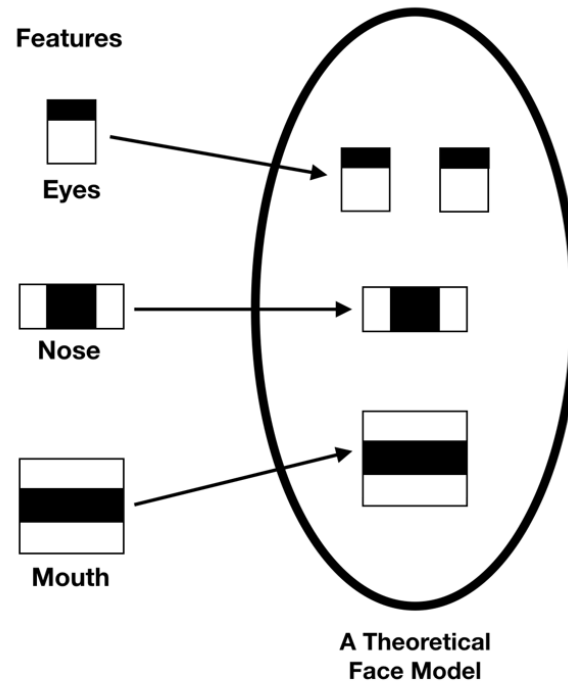


FIGURE 7. Face features extraction (Dwivedi 2018).

In face detection, the algorithm detects the most relevant features in a human face. Haar-features are therefore the most relevant features for face detection. FIGURE 7 shows the cascade feature of the eyes, nose, and mouth of a person. These cascade features are pre-trained. Eyes feature is considered an edge feature. whereas nose and mouth, features are line features. The algorithm uses biometrics to analyse the shape and size of the required object.

5.1 Requirements

Before starting a facial recognition project, every programmer should know about all the necessary tools for the project. In this project, an i7 processor 2.8GHz with 16 GB of memory running Windows 10

operating system was used. The latest version of Python 3.8.0 in 64-bit and OpenCV 4.2.0 was installed on the system. Similarly, PyCharm IDE was being used for coding purposes. Previously trained Haar Cascade classifiers for faces and eyes have been downloaded from the Haar Cascade directory.

5.2 Project Framework

The development of this project framework explains the knowledge and ideas about the models and key concepts involving different approaches. There are various concepts and approaches to face recognition. The project has been significantly divided into three main categories, beginning with face detection and data gathering, training, and recognition, respectively. The following FIGURE 8 demonstrates the three major steps where it initially detects a face. When the face is recognized, it goes further to identify the user.

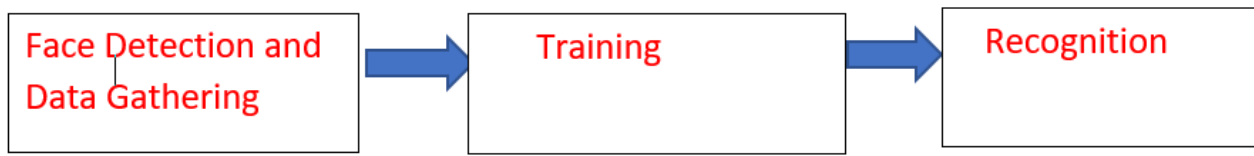


FIGURE 8. Steps involve in face recognition

FIGURE 8 shows the different steps involved in face recognition for this project. First, face detection and data gathering were done using OpenCV and previously trained Haar-feature based cascade classifiers. The face cascade was being used to detect the face. Similarly, eyecascade classifier was being used to detect eyes. Second, the author's Haar Cascade model was designed for training purposes. Sample faces have been extracted and trained in the model with a total of 60 sample faces. Finally, the trained model was used for recognition purposes.

5.2.1 Face Detection and Data Gathering

One of the very basic tasks of face recognition is face detection. The face must be captured in order to recognize it. For this project, a computer webcam was used to capture a real-time facial image. Firstly, the python-OpenCV module was installed in a system that helped import all the necessary modules.

Python programming language has been already installed in a system along with PIP, which is a manager for all the python packages. Python-OpenCV module has installed using the command prompt by using `pip install OpenCV-Python` command.

Normal images are in the form of an RGB channel (Red, Green, Blue) which describes a colour with three components. Each component takes a value between 0 and 255, where the tuple (0, 0, 0) represents black and (255,255,255) represents the white colour. OpenCV stores the images in the BGR channel (Blue, Green, Red). Therefore, the detected image has been shown in the BGR format. OpenCV reads the colour image file as a NumPy array.

While capturing the video, a Primary camera has been used for this project. Where (0) refers to the primary camera, which can be seen in FIGURE 9. VideoCapture has the name of a video file or the device index. It is just to specify the camera used to capture the video. The second camera can also be used by using number 1. The primary camera has captured the video frame-by-frame, which can be seen in FIGURE 9.

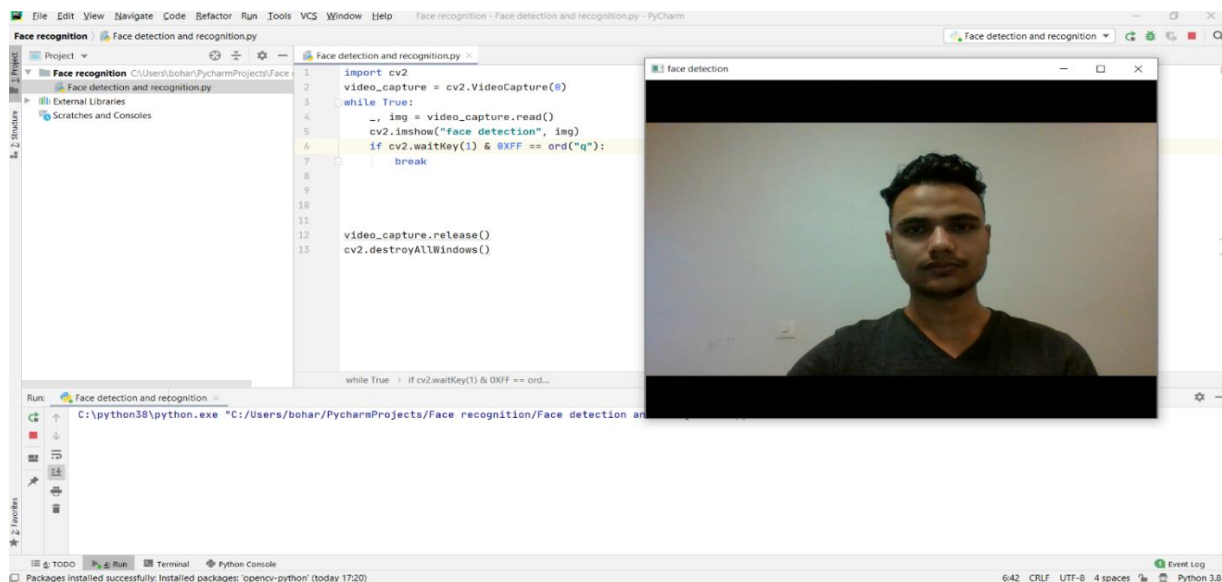


FIGURE 9. Video capturing

A built-in webcam was used to capture the video, which can be seen in FIGURE 9. It was clear that the video capture program was working well. The `cv2.imshow()` function showed the video in a window

with a window named Face detection. Similarly, the waitkey function has been assigned where the number 1 in waitkey represents the display of running window infinitely. Furthermore, the assigned 'q' key helps to break the running window. The same face was used for detection. The algorithm detected face and captured frame-by-frame, which can be seen in FIGURE 10.

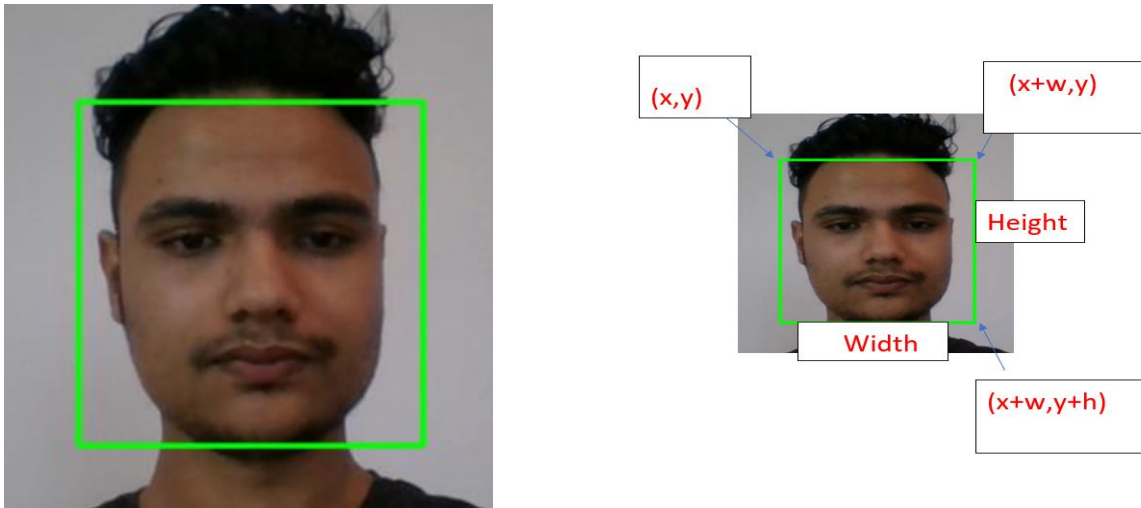


FIGURE 10. Detected face with (x, y, w, h) coordinates

FIGURE 10 shows the final detected image. The provided algorithm for face and eyes has worked well and detected the facial area. Moreover, the algorithm used to detect the face and eyes made the rectangular areas around the face and eyes. OpenCV provides a detectMultiscale module in which the algorithm created a rectangle around the face detected in an image. In FIGURE 10, the detected feature of a face having x-coordinate, y-coordinate, width (w), and height (h) has been shown. The coordinates (x, y, w, h) made the rectangular box around the detected face to show the region of interest.



FIGURE 11. Face and eye detection

Similarly, for eye detection, a cascade classifier has been created for the eyes. The eye can only be detected inside the face. Thus, the face was the region of interest for the eyes. Moreover, the multiscale module created a rectangle around the eyes to detect the position of the eyes on the face. Similarly, the detected eyes inside the face can be seen in FIGURE 11. As well as the algorithm was able to detect a face and eyes. Also, the face detection algorithm was tested in larger and smaller pictures in which, a face and eyes were detected, and the algorithm worked well.

5.2.2 Training

For training, a face dataset had been created. First, a new directory has been created with named data. Parameters have been given to the directory to generate image datasets. To detect and recognize a specific person, a facial image dataset has been trained with a specific identification of a person. The data directory contained a dataset of facial images of a single person. All images were taken from a different angle for an accurate result. Besides, each training image with the same pixel value and unique identification has been taken for the training.

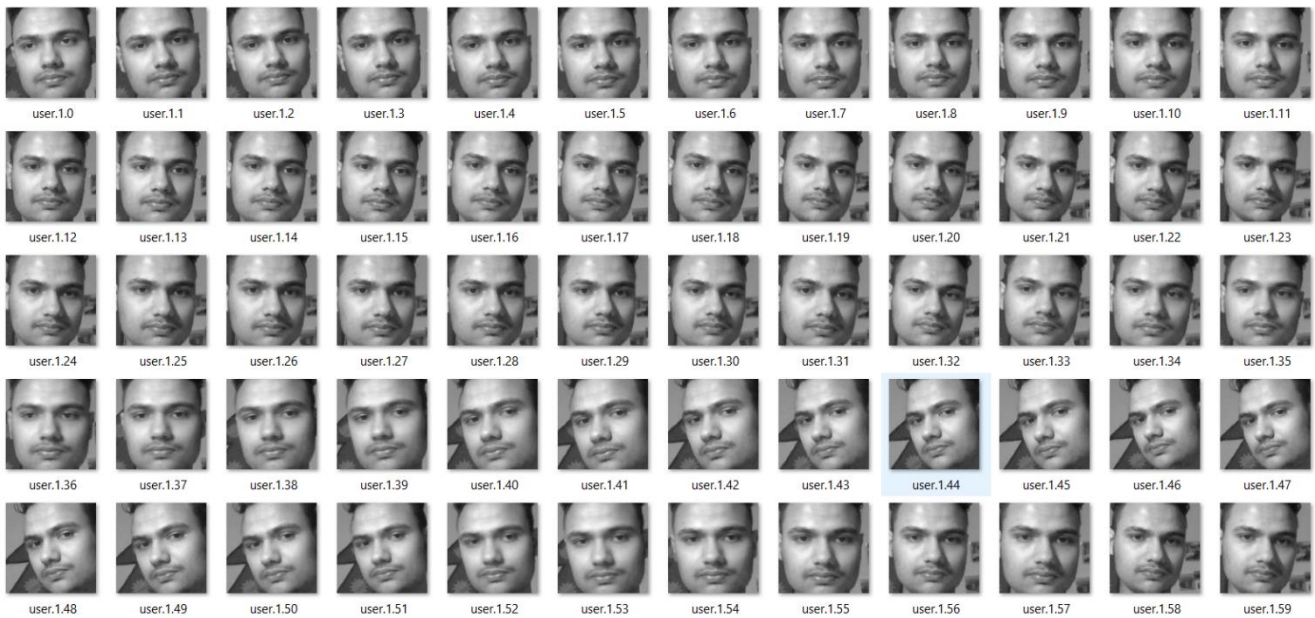


FIGURE 12. Image dataset

The training dataset had been generated with a total of 59 images of a single person. All images have a unique user identification and image number. In FIGURE 12 all the images are positive images of a single person, which have been taken using the default webcam. The image dataset containing grayscale images had been taken from a different angle for accurate recognition. Additionally, different facial expressions have been captured to recognize the person from every angle.

5.2.3 Recognition

The previously trained dataset in FIGURE 12 had taken for recognition. All the facial images have been extracted, cropped, resized, and converted to grayscale where the algorithm found the characteristics in the image. To recognize a person, a new classifier had been trained to classify and recognize. For this, a new python file had been created. Likewise, the Local Binary Pattern Histogram algorithm (LBPH) had been used for recognition, which is provided by the OpenCV library. The algorithm was trained using the dataset of facial images. Each image used for recognition has the same ID. In FIGURE 14 the dataset of facial images has a person ID and image ID.

```

1 import numpy as np
2 from PIL import Image
3 import os
4 import cv2
5 import flask
6
7
8 def train_classifier(data_dir):
9     path = [os.path.join(data_dir, f) for f in os.listdir(data_dir)]
10    faces = []
11    ids = []
12    for image in path:
13        img = Image.open(image).convert("L")
14        imageNp = np.array(img, 'uint8')
15        id = int(os.path.split(image)[1].split(".")[1])
16        faces.append(imageNp)
17        ids.append(id)
18    ids = np.array(ids)
19    clf = cv2.face.LBPHFaceRecognizer_create()
20    clf.train(faces, ids)
21    clf.write("classifier.yml")
22    train_classifier("data")

```

FIGURE 13. Classifier training

In FIGURE 13, the classifier had been trained using previously trained facial image data. Firstly, all the modules had been imported. The classifier method had been created and the data directory containing facial images had been taken in the classifier method. Each image has a user ID and an image ID. Similarly, after all the lists had been prepared, the classifier had trained using the LPBH algorithm, which trained the provided faces and user ID. After running the program, a new file (classifier.yml) was generated. The classifier.yml was the classifier to recognize the face.

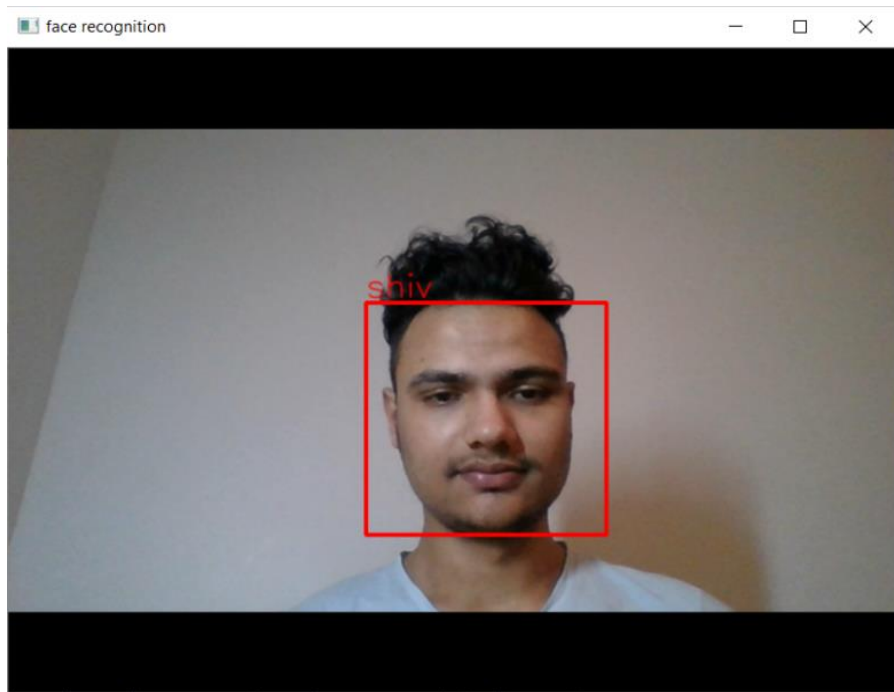


FIGURE 14. Recognized image

Finally, the system has performed a face recognition process. The face has been detected and recognized in a window with name face recognition. The recognizer labeled the face as shiv, which is the identification of the author. The author's facial picture had been used in real-time for facial detection and recognition. FIGURE 15 shows the final recognized face of a single person. The system used the biometrics to map the facial features from a video. Further, if any new face image comes into the camera, the system recognizes the face based on the facial features.

6 CONCLUSION

Artificial intelligence seems to be taking the world to the next level. The artificial intelligence and machine learning technology of the present generation have changed every area of society. Moreover, many impossible circumstances that are challenged by human beings can be solved with the aid of the latest technologies such as artificial intelligence and machine learning. The transformation of technology from the past couple of decades to the present has been skyrocketed effortlessly. In contrast, machine learning is also a branch of artificial intelligence that delivers systems the possibility to learn automatically and improve from experience by using data. Many companies for instance robotics, industries, health care, social media, computer vision, gaming, mobile phones. have been broadly synchronized with these technologies. Since the impact of technological change on the global economic structure is creating enormous transformations in the way in which new products are organized, traded, invested, and developed. Advanced manufacturing technologies have altered long-term patterns of productivity and employment as well. The rapid growth of innovation and the dynamics of technology flows have substantial advantages in terms of livelihood. Hence, the transition in technology has enabled many developed and developing countries to connect technology more efficiently with the higher expectation of making higher living standards.

Artificial intelligence simply is computer software with a mechanism to simulate human intelligence. Once this software is built with the help of various algorithms and machine learning modules it can read images, text, video, or audio. In addition, machine learning is a technique based on artificial intelligence for developing an intelligent computer system. These Days, the self-driving car works with artificial intelligence and machine learning technology. Further, medical treatment, forensics, and other miscellaneous fields are also applicable.

In this project, real-time face detection and recognition had done to detect the face and eyes in an image. Haar Cascade machine learning object detection algorithm was used to detect the objects in an image. Moreover, it deliberates the closest rectangular regions at a particular location in a detection frame. Similarly, a local binary pattern histogram algorithm was used to recognize the detected face and finally recognized the image. For instance, edge features, line features, and four-rectangle features are constructed in an algorithm to detect the facial image. To detect the accuracy of an object, a cascade classifier is organized. Cascade classifier is mainly defined by the location of an image by sliding, either positive or negative. Positive signifies that the image is found, which is the preliminary focus in this

project. Therefore, the use of artificial intelligence and machine learning has become more common in many sectors. The current field of artificial intelligence has come into existence in human life, resulting in substantial progress and making the standard of living better.

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